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ATMOSPHERIC CORROSION PROGRAMME ISO-CORRAG

Report on the second year of exposure
at the Boucherville site near Montréal
Canada

October 16th 1987 - October 17th 1988

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I) EXPERIMENTAL

Experimental procedures as in the report on the first year (Oct. 1986 - October 1987) except for the chloride deposition rate, where analysis of the chloride was done using an ion chromatographic technique instead of the volumetric titration described in ISO DP-9225. Ion chromatography proved to be more precise than the volumetric method.

II) RESULTS

The report on the first year contained all results corresponding only to the first one-year period of exposure (period #11 of the Programme). This report gives the results for the following periods of exposure :

Period #12 : a one-year period from April 14th 1987 to April 19th 1988
Period #13 : a one-year period from October 16th 1987 to Oct. 17th 1988
Period #21 : a two-year period from October 17th 1986 to Oct. 17th 1988.

1) Corrosion rates

All values are given in tables 1 and 1 bis . Figures 1 to 4 show their variations with time for periods 11, 12, 13 and 21 . Additional information on the aluminium samples is given in table 2 .

2) Resistance probes

Values of K and the mean calculated thicknesses of the resistance are given in table 3 for three sets of probes whose exposure started respectively in April 1987, October 1987 and April 1988. The useful lifetime of these probes is 6 to 8 months. After such a period , the exposed resistance separates from its substrate and its underside starts to corrode giving thus values of K which are too high. The study of the copper probes was discontinued due to the fact that the thickness of the available probes was too high.

3) Environmental data

All measured values are given in table 4.

III) CURRENT STATUS

On April 19th 1988 and on October 17th 1988 two new sets of samples were exposed (periods #14 and #15 of the Programme). No special problems have arisen.

TABLE 1 - RESULTS OF 1 YEAR EXPOSURE
TEST SITE: BOUCHERVILLE, QUÉBEC, CANADA
1987 - 1988

No. of exposure	FLAT SPECIMENS					HELIX SPECIMENS				
	Exposure from/to	Corrosion rate (µm/y)				Exposure from/to	Corrosion rate (µm/y)			
		Steel	Zinc	Copper	Aluminium		Steel	Zinc	Copper	Aluminium
12	21/04/87 19/04/88	1. 21.52	1.57	1.21	0.42	21/04/87 19/04/88	1. 24.44	1.93	1.09	0.28
		2. 21.68	1.57	1.12	0.42		2. 24.46	1.87	1.13	0.29
		3. 22.38	1.63	1.19	0.42		3. 24.48	1.82	1.14	0.32
		Ø. 21.53	1.59	1.17	0.42		Ø. 24.46	1.87	1.12	0.30
13	16/10/87 17/10/88	1. 30.75	1.33	1.12	0.38	16/10/87 17/10/88	1. 28.54	2.11	1.36	0.42
		2. 26.94	1.30	1.06	0.36		2. 27.47	1.91	1.34	0.32
		3. 27.28	1.32	1.07	0.39		3. 27.49	2.05	1.38	0.34
		Ø. 28.32	1.32	1.08	0.38		Ø. 27.84	2.02	1.36	0.36

TABLE 1bis - RESULTS OF LONG TERM EXPOSURE
TEST SITE: BOUCHERVILLE, QUÉBEC, CANADA
1987 - 1988

No. of exposure	FLAT SPECIMENS					HELIX SPECIMENS				
	Exposure from/to	Corrosion rate (µm/y)				Exposure from/to	Corrosion rate (µm/y)			
		Steel	Zinc	Copper	Aluminium		Steel	Zinc	Copper	Aluminium
	2 years exposure					2 years exposure				
21	17/10/86 – 17/10/88	1. 16.83	1.23	0.81	0.18	17/10/86 – 17/10/88	1. 20.27	1.53	0.89	0.43
		2. 16.84	1.30	0.82	0.17		2. 20.77	1.61	0.91	0.38
		3. 15.44	1.21	0.81	0.17		3. 20.35	1.53	0.91	0.41
		Ø. 16.37	1.24	0.81	0.18		Ø. 20.46	1.56	0.90	0.40
	4 years exposure					4 years exposure				
41							1.			
							2.			
							3.			
							Ø.			

TABLE 2 - RESULTS OF EVALUATION OF LOCAL ATTACK OF ALUMINIUM
TEST SITE: BOUCHERVILLE, QUÉBEC, CANADA
1986 - 1988

No. of exposure	Exposure from/to	FLAT SPECIMENS					
		Area (%)		Pit depth (μm)			
				P mean		P extr.	
		A	B	A	B	A	B
11	17/10/86 to 16/10/87	1.0	1.9	18.5	17.2	57.0	50.4
12	21/04/87 to 19/04/88	1.1	3.6	6.5	6.3	22.2	16.5
13	16/10/87 to 17/10/88	2.3	3.1	10.4	7.8	27.0	25.6
14 15 16							
21	17/10/86 to 17/10/88	2.6	3.4	14.2	18.6	33.5	60.4
41 X1							

Note: A - top side of specimen
B - lower side of specimen.

TABLE 3 - STEEL RESISTANCE PROBES

PROBE	OCT. 87	NOV. 87	DEC. 87	JAN. 88	FEB. 88	MAR. 88	APR. 88	MAY 88	JUNE 88
Steel #1	1.028	1.057	1.088	1.110	1.160	1.201	1.203	1.255	1.295
Steel #2	1.011	1.038	1.077	1.142	1.148	1.175	1.192	1.224	1.260
Steel #3	1.003	1.035	1.071	1.148	1.176	1.197	1.236	1.280	1.327
Mean	1.014	1.043	1.079	1.133	1.161	1.191	1.210	1.253	1.294
Mean thickness (μm)	100	97.2	94.0	89.5	87.3	85.1	83.8	80.9	78.4

PROBE	APR. 87	MAY. 87	JUNE 87	JULY 87	AUG. 87	SEPT. 87	OCT. 87
Steel #1	1.009	1.024	1.051	1.081	1.113	1.113	1.139
Steel #2	0.997	1.017	1.050	1.067	1.090	1.107	1.119
Steel #3	1.005	1.024	1.061	1.096	1.101	1.127	1.140
Mean	1.004	1.022	1.054	1.081	1.101	1.116	1.133
Mean thickness (μm)	100	98.2	95.3	92.9	91.1	90.0	88.6

PROBE	APR. 88	MAY 88	JUNE 88	JULY 88	AUG. 88	SEPT. 88	OCT. 88
Steel #1	0.987	--	1.019	1.043	1.099	1.046	1.152
Steel #2	0.990	--	1.010	1.033	1.083	1.134	1.120
Steel #3	1.017	--	1.033	1.048	1.100	1.147	1.180
Mean	0.998	--	1.021	1.041	1.094	1.109	1.151
Mean thickness (μm)	100	--	97.8	95.8	91.2	90.0	86.7

TABLE 4 - YEARLY SURVEY OF ENVIRONMENTAL DATA
TEST SITE: BOUCHERVILLE, QUÉBEC, CANADA
OCTOBER 87 TO SEPTEMBER 88 (2nd YEAR)

Month	ENVIRONMENTAL CHARACTERISTIC					
	Temperature Ø (°C)	Rel. Humidity Ø (%)	SO_2 Ø dep. mg./d.m.^{2}	NaCl Ø dep. mg./d.m.^{2}	Calculated Time of wetness t 0°C RH 80% (hrs)	Measured Time of wetness (hrs)
1(oct.)	8	70	15.6	24	163	121
2	1	72	13.5	37	95	111
3	-3	78	17.4	37	134	325
4	-8	69	29.4	117	52	387
5	-8	69	17.5	129	36	316
6	-2	60	8.6	36	54	178
7	7	69	6.2	27	200	160
8	16	59	7.1	31	114	91
9	19	54	10.5	55	49	59
10	24	67	7.4	45	179	113
11	22	68	7.1	41	190	116
12(sept.)	16	67	7.9	35	145	111
Ø	8	67	12.4	55	118	174
Total	--	--	148	664	1411	2087

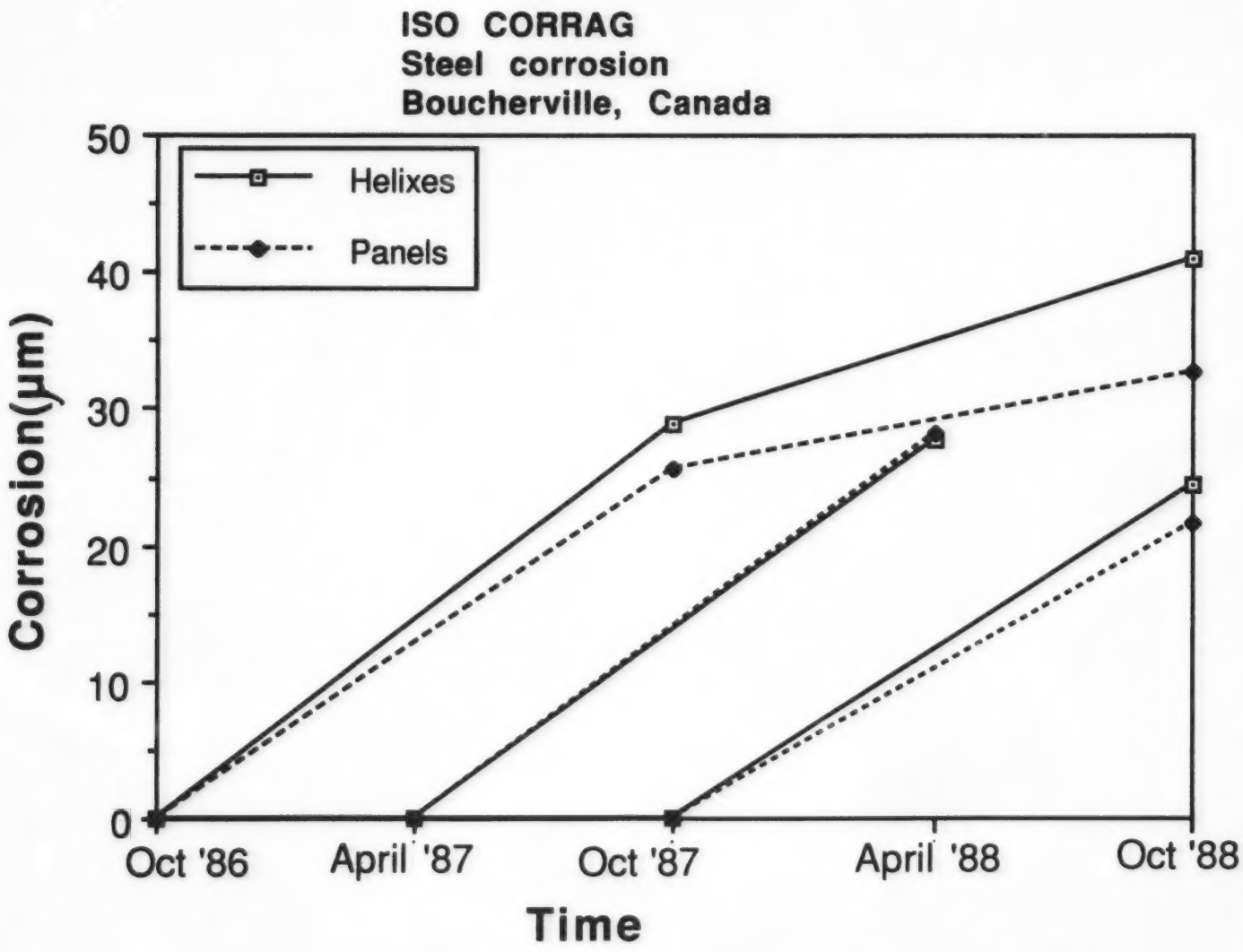
ISO CORRAG
Steel corrosion
Boucherville, Canada
Helixes
Panels
Corrosion(µm)
50
40
30
20
10
0
Oct '86
April '87
Oct '87
April '88
Oct '88
Time

Fig. 1

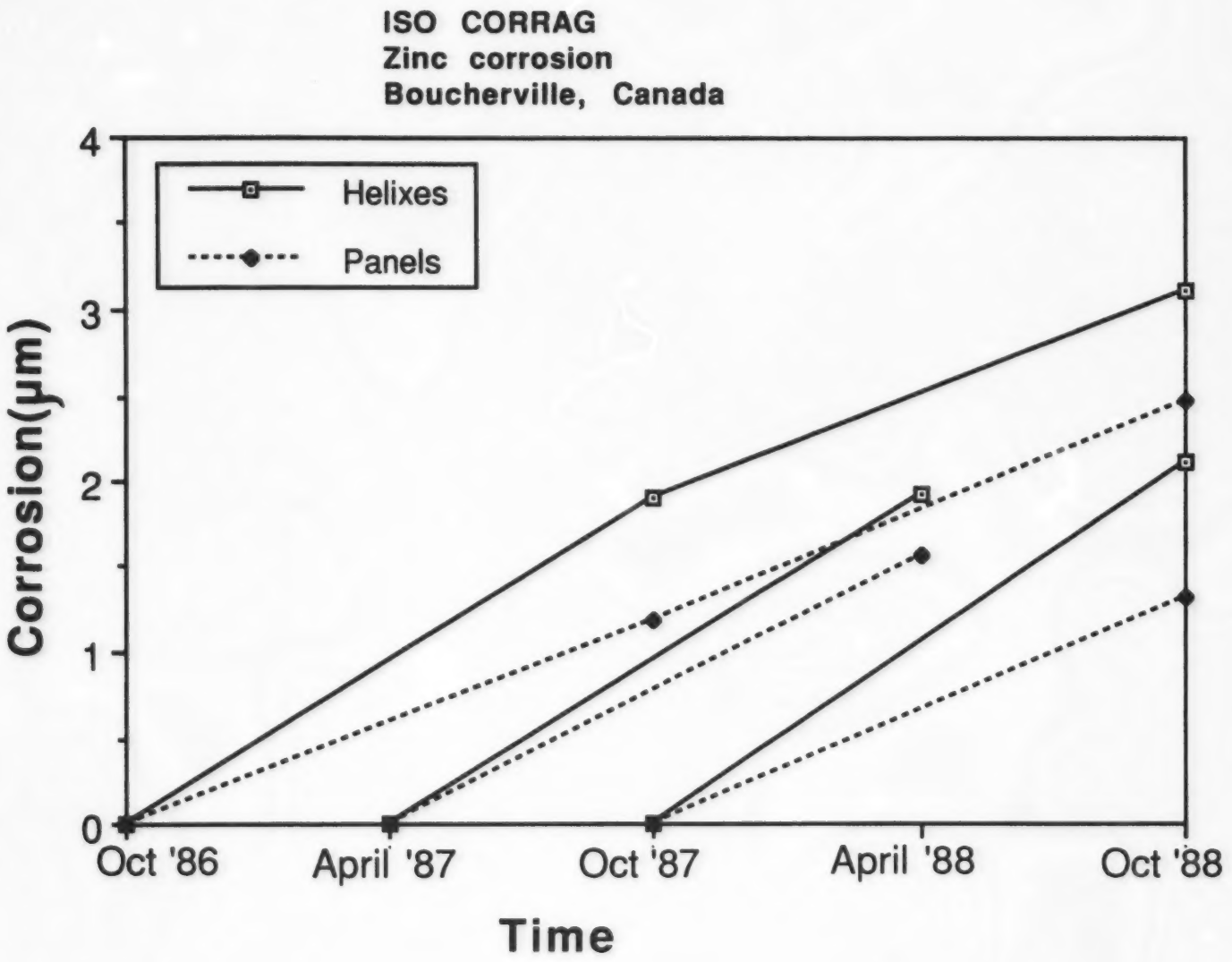
ISO CORRAG
Zinc corrosion
Boucherville, Canada
Helixes
Panels
Corrosion(µm)
0
1
2
3
4
Oct '86
April '87
Oct '87
April '88
Oct '88
Time

Fig. 2

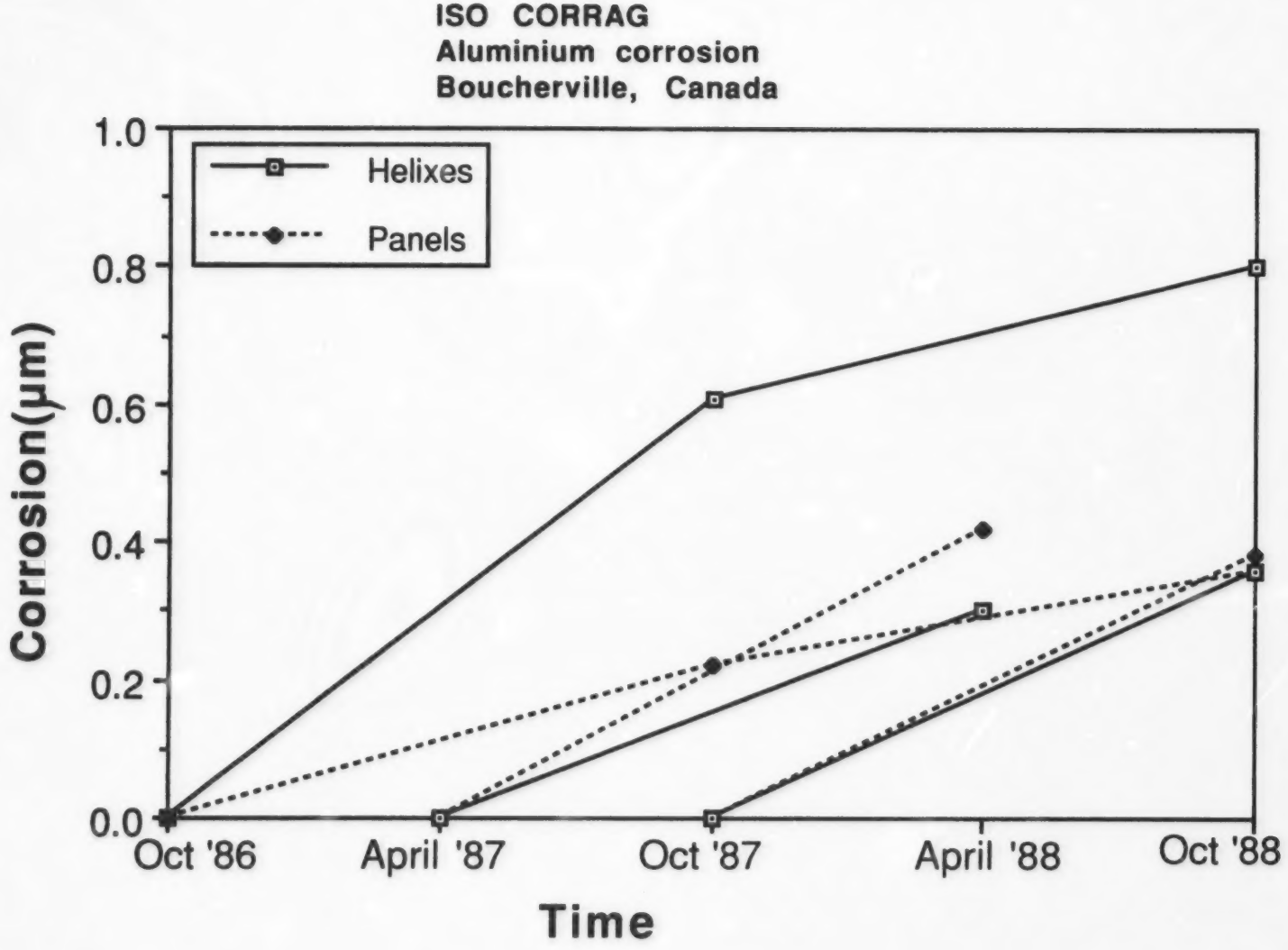
ISO CORRAG
Aluminium corrosion
Boucherville, Canada
Helixes
Panels
1.0
0.8
0.6
0.4
0.2
0.0
Corrosion(µm)
Oct '86
April '87
Oct '87
April '88
Oct '88
Time

Fig. 3

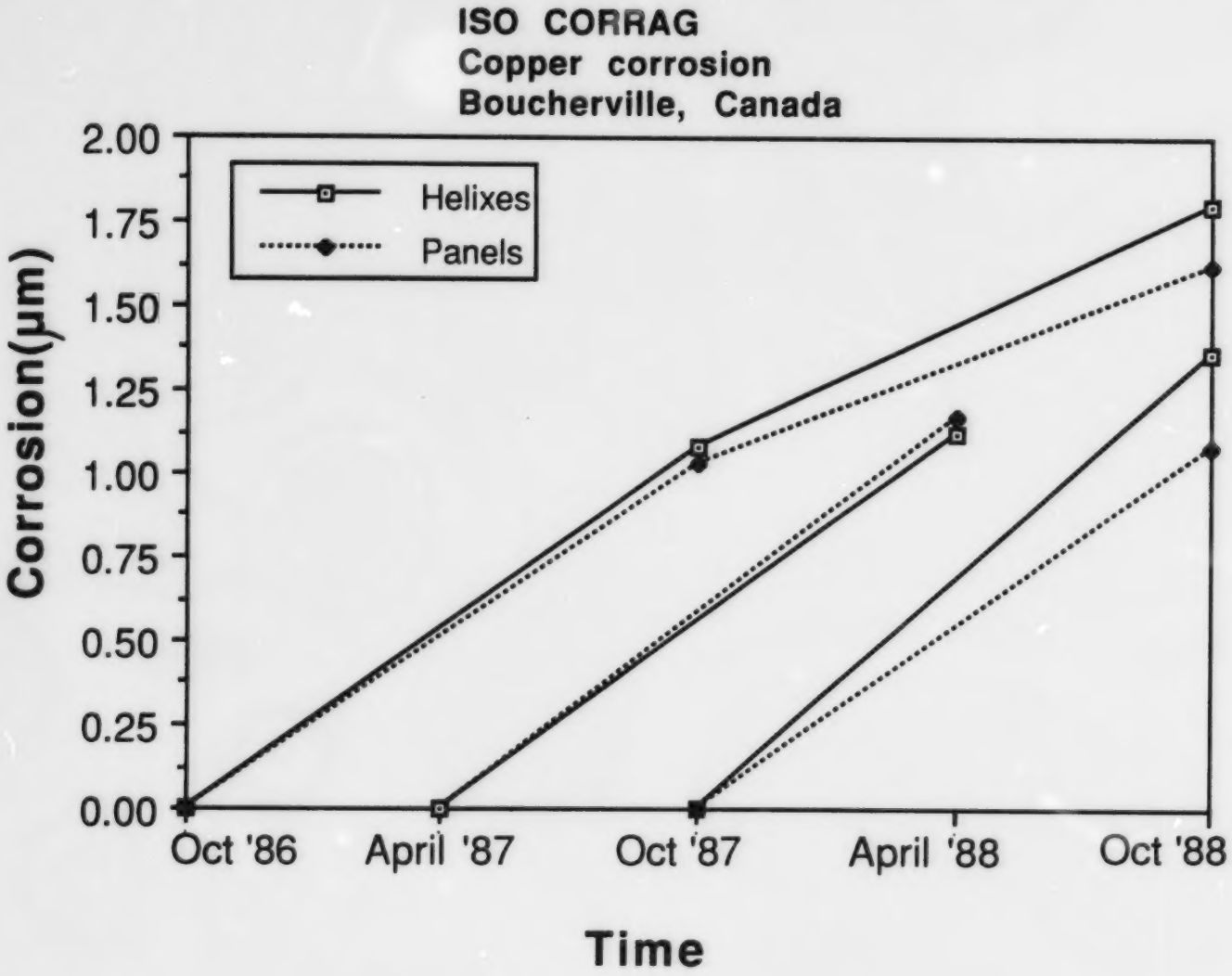
ISO CORRAG
Copper corrosion
Boucherville, Canada
Helixes
Panels
Corrosion(µm)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Oct '86
April '87
Oct '87
April '88
Oct '88
Time

Fig. 4